



QuakeCoRE

NZ Centre for Earthquake Resilience  
*Te Hiranga Rū*

## **2019 Collaboration Plan**

### **QuakeCoRE: Centre for Earthquake Resilience**

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Proposals Due Noon (NZT) 19 October 2018

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# 1. Key Information: 2019-20 Collaboration Plan

Below is the key information about the 2019-20 QuakeCoRE Request for Proposals (RfP):

- Request for Proposals (RfP) Summary
  - Project proposals are invited in three key areas:
    - A: Research Masters Scholarships
    - B: Flagship and Special Project Research Projects
    - C: Vision Mātauranga Focused Projects
  - Project funding will be for 21 months and will cover the period from 1 January 2019 – 30 September 2020. Due to QuakeCoRE's TEC funding restrictions, the end date for these projects will be strictly enforced; there will be no opportunity to extend these projects under any circumstances.
- Research Masters Scholarships:
  - Applications for project funding are invited to support Research Masters students in the field of earthquake resilience. The project topic should be outlined in the application form, the student does not yet need to have been identified. Project funding will include student fees (at the domestic rate) and a twelve month student stipend.
- Flagship and Special Project Research Projects:
  - Flagships
    - Flagship Programmes are comprised of non-contestable Coordinated Flagship Projects and contestable Flagship Research Projects funded under this RfP.
    - The Flagship Leaders have submitted a non-contestable Coordinated Flagship Project for review and endorsement. We encourage investigators to engage with the Flagship Leaders to understand the opportunities to contribute to or align with this critical component of the overall Flagship Programme.
    - Contestable Flagship Research Projects (funded under this RfP) will complement the Coordinated Flagship Projects while still meeting the objectives of the Flagship Programmes described in Section 8; summaries of the 2019-20 Coordinated Projects Plans are available [here](#).
  - Special Projects
    - Special Projects are major long-term externally-funded research programmes which are aligned with the QuakeCoRE mission. Special Project designation enables a programme to be included in the Annual RfP, allowing QuakeCoRE contestable funding to be used to support research synergies through aligned projects that contribute toward the QuakeCoRE mission, as well as its core values and culture.
    - *Spatially-distributed Infrastructure* has been designated as a Special Project to reflect the relationship and coordinated research synergies

with the Resilience National Science Challenge (RNC) – infrastructure toolbox.

The current funding for the RNC infrastructure toolbox finishes on 30 June 2019. A summary of the current Resilience National Science Challenge (RNC) – infrastructure toolbox is available [here](#). The second phase of RNC funding is in process, but has not yet been confirmed. All project leaders planning on submitting a RfP proposal to support Special Project 1 (SP1) must contact Liam Wotherspoon (Special Project 1 Leader) prior to submission to ensure that their project proposal is well aligned with the current Special Project 1 and RNC activities.

- Vision Mātauranga Focused Projects:

QuakeCoRE is actively seeking to increase our focus on Vision Mātauranga and Mātauranga Māori in the CoRE. This funding aims to support and develop projects with a strong Vision Mātauranga component that can contribute to the QuakeCoRE Vision Mātauranga strategy and research programme delivery.

- Technology Platforms & Outreach:

No Expressions of Interest (EOIs) for Technology Platforms and Education, Outreach and Training projects are being solicited through this RfP process, instead investigators are encouraged to contact Technology Platform Leaders and our Outreach Coordinator at any time with ideas for collaboration. Both the Outreach and Technology Platform Leaders will submit an annual non-contestable programme for review and endorsement.

- Travel:

No applications for travel grants to attend the QuakeCoRE Annual Meeting will be accepted as part of the RfP in 2019-20. Instead Annual Meeting travel grant applications will be aligned to the registration for the Annual Meeting each year. Travel grants will be available to Associate Investigators (AIs) and Industry Affiliates, where they don't have Annual Meeting travel funding via a project.

- Workshops:

No expressions of interest for workshops aligned with the Annual Meeting are being sought via the RFP.

At this time, we are seeking initial ideas for workshops aligned to the Annual Meeting. Ideas can be submitted until early 2019 through a brief online form available [here](#).

In particular, we are interested in ideas for workshops that address cross-disciplinary collaboration or which support future focused research activities (for example to support the rebid development). Ideas for workshops in a single

Flagship or Technology Platform areas should be directed to the Flagship or Technology Platform Leader.

## **2. Introduction**

QuakeCoRE supports and co-ordinates research in earthquake resilience, providing a focal point for national and international collaborations. QuakeCoRE is a Centre of Research Excellence (CoRE) funded by the Tertiary Education Commission (TEC) from 1 January 2016 – 31 December 2020.

*QuakeCoRE's mission* is to place Aotearoa New Zealand at the worldwide forefront of earthquake disaster resilience by utilizing Aotearoa New Zealand as a natural earthquake laboratory, producing new knowledge on the seismic response of the built environment, developing models to understand vulnerabilities within this environment, and designing innovative technologies and decision-support tools enabling rapid recovery of Aotearoa New Zealand communities.

*QuakeCoRE's vision* is an earthquake-resilient Aotearoa New Zealand where thriving communities have the capacity to recover rapidly after major earthquakes through mitigation and pre-disaster preparation informed by internationally-leading research excellence.

The first five year phase of QuakeCoRE (2016-2020) will advance earthquake resilience through highly integrated multi-disciplinary and multi-institutional collaborations that are enabled through experimental, data and computational Technology Platforms. The scope of QuakeCoRE research encompasses areas in earthquake resilience that are inter-related and require an inter-disciplinary, multi-institutional approach. Interdisciplinary research initiatives focus on multi-thematic Flagships, and the development of Technology Platforms which provide community facilities, data, and modelling environments to efficiently facilitate collaborative world-class multi-disciplinary and multi-institutional research.



Figure 1: QuakeCoRE's research structure comprising of Technology Platforms, Flagship Programmes, Special Projects and Integrative Projects.

## **Key Initiatives**

**Technology Platforms:** Four Technology Platforms provide the underpinning experimental (lab and field), data, and computational infrastructure which are necessary for realizing QuakeCoRE's vision and mission, and involve cross-institutional and industry collaborations.

**Flagship Programmes:** Flagships include a long-term non-contestable Coordinated Flagship Project led by the Flagship Leader. The Coordinated Flagship Projects are supported by RfP-funded Flagship Research Projects that are research excellent, have strong collaboration, build human capacity, and are coordinated with other funding support. The Flagship Programmes described in this Collaboration Plan integrate successful on-going projects by QuakeCoRE investigators and leverage additional funding to achieve significant impacts for Aotearoa New Zealand.

**Special Projects:** These are major long-term externally-funded research programmes which are aligned with the QuakeCoRE mission. Special Project 1 "Spatially-distributed infrastructure" has been included in the RfP, further details can be found in Sections 5 and 8.

**Integrative Projects:** These multi-disciplinary projects provide an opportunity for interaction between Flagships and Technology Platforms around a research topic. There are currently two non-contestable integrative projects in development; one around the Alpine Fault and a second focused on Wellington. Applications for Integrative Projects are not currently being accepted.

**Education, Outreach and Training:** QuakeCoRE's research activities aim to address the full education pathway from primary school to PhD including student research and internship experiences. QuakeCoRE researchers that wish to participate in Education, Outreach and Training activities are encouraged to contact our Outreach Coordinator at any time with ideas for collaboration.

**Annual Collaboration Plan:** This document, referred to as the *Annual Collaboration Plan*, describes the mechanisms for collaboration and solicits proposals from investigators to participate in the QuakeCoRE programme.

### 3. Proposal timelines

The timelines for Research Masters Scholarships, Flagship and Special Project Research Projects, and Vision Mātauranga Focused Project proposals are:

- 21 September 2018: Request for Proposals (RfP) released
- Friday 19 October Noon NZT: Applications close. Late proposals will not be accepted
- November: Evaluation and review process
- Mid-December: Outcomes advised
- 1 January 2019: Projects commence

### 4. Guidelines for proposal submission

**Submission Instructions:** Proposals must be submitted via the online application portal. The online application portal can be found [here](#).

**Formatting Instructions:** All proposals must use the QuakeCoRE RfP Application Form Template available on the QuakeCoRE website [here](#).

**Investigator responsibilities:** To achieve the QuakeCoRE mission, QuakeCoRE investigators are expected to interact with the QuakeCoRE community on a regular basis (eg attending the Annual Meeting and presenting QuakeCoRE-funded research in the poster sessions, attending monthly Flagship calls and the QuakeCoRE Seminar Series), and to contribute all relevant data, experimental and analysis results and computational codes/models to the appropriate QuakeCoRE Technology Platforms. Publications resulting entirely or partially from QuakeCoRE funding must include a QuakeCoRE publication number and funding acknowledgement. By submitting a proposal, investigators are agreeing to these conditions, and performance in this regard will be considered in future QuakeCoRE proposals.

**Eligibility:** Specific eligibility is as follows

- A: Research Masters Scholarships
  - Limit of one application per investigator as the project lead.
  - Proposals can only be submitted by QuakeCoRE Associate Investigators (AIs) or Principal Investigators (PIs).
  - Flagship Leaders are eligible to apply but clear and compelling reasons must be given as to why the proposed project is not being supported via Coordinated Flagship Project funding or other QuakeCoRE funding.

- B: Flagship and Special Project Research Projects
  - Limit of one application per investigator as the project lead.
  - Proposals can only be submitted by QuakeCoRE Associate Investigators (AIs)
  
- C: Vision Mātauranga Focused Projects
  - Limit of one application per investigator as the project lead
  - Proposals can only be submitted by QuakeCoRE Associate Investigators (AIs) or Principal Investigators (PIs).
  - Flagship (and Integrative Project) Leaders are eligible to apply but clear and compelling reasons must be given as to why the proposed project is not being supported via Coordinated Flagship Project funding or other QuakeCoRE funding.

**Budget guidance:** Flagship and Special Project Research Project proposals and Vision Mātauranga Focused Projects funded under this Annual Collaboration Plan cannot exceed \$70,000 (excluding GST). Projects should be of a reasonable scale ie minimum of \$20,000 so as to minimise high administrative overheads for small projects.

Note that budgets cannot include AI or PI salary, CapEx and international conference travel. Postgraduate student stipends should be at the rate of 1) \$15,000 for a fulltime Masters stipend with compulsory domestic tuition fees or 2) \$25,000 for a fulltime PhD student stipend with compulsory tuition fees.

QuakeCoRE Annual Meeting Travel funding of up to \$1,000 per year should be included in the budget for all key research contributors.

Given the modest scale of these projects, and to manage administrative overhead, careful consideration should be given before including small and/or numerous subcontracts.

Funding for Research Masters Scholarship project proposals is limited to the following support; fees at the domestic rate, a student stipend of \$15,000 for twelve months and Annual Meeting Travel.

**Award procedures:** QuakeCoRE is funded by the TEC as a Centre of Research Excellence (CoRE). All dispersed funding will be in the form of a standardized subcontract from the University of Canterbury as host institution, and subject to the conditions of the funder, TEC.

**Review and Evaluation:** Review coordination and evaluation of proposals is performed by the RfP Review Panel (comprising the QuakeCoRE Leadership Team and industry representatives for each Flagship and Special Project Programme, or delegates), and proposals will be either funded or rejected, without negotiation with the project leader.

## 5. Proposal categories

Proposals for 21 months of funding are encouraged across the following three categories.

**Research Masters Scholarships:** Applications for project funding are invited to support Masters Students in the field of earthquake resilience. The project topic should be outlined in the application form, and should demonstrate good alignment with the QuakeCoRE research programme. The Masters Student does not yet need to have been identified at the time of the funding submission but must have started by 1 July 2019. Project funding will include student fees (at the domestic rate), a twelve month student stipend and Annual Meeting travel support. The project outline should include details of aligned support that will contribute to the project; such as funding for project consumables.

**Flagship and Special Project Research Projects:** Flagship and Special Project Research Projects are high-impact research projects that are advanced to the next level through strong research collaboration, engagement with end-users, and coordination with other funding support. Flagship and Special Project Research Project Proposals in this category should identify the specific Flagship Programme or Special Project Programme and associated research thrust their proposal contributes to (see Section 8.1). Flagship and Special Project Research Project proposals should consist of a single objective.

Special Projects are major long-term externally-funded research programmes, for example a National Science Challenge, which are aligned with the QuakeCoRE mission. Special Project designation enables a special project programme to be included in the Annual RfP, such that QuakeCoRE contestable funding, can be used to provide support for research synergies through aligned projects that contribute toward the QuakeCoRE mission, as well as its core values and culture.

*Spatially-distributed Infrastructure* has been designated as Special Project One (SP1) to reflect the relationship with the Resilience National Science Challenge. RfP proposals under this Special Project follow the same process as the Flagship Research Projects described above.

**Vision Mātauranga Focused Projects:** Applications are invited to support and develop projects with a strong Vision Mātauranga component that can contribute to the QuakeCoRE research programme delivery and mission.

We are currently seeking applications that support delivery on our Vision Mātauranga strategy in particular to establish research projects that deliver on Māori research priorities to enhance Māori and national built, social, economic, and environmental resilience to earthquakes. For example supporting researchers and key stakeholder Māori institutions to deliver a shared concept of research needs or multi stakeholder research projects that focus on delivering on Māori research priorities.

## 6. Evaluation process and criteria

Proposals submitted should respond directly to the Annual Collaboration Plan. A primary consideration in evaluating proposals will be how directly the proposal addresses the mission and vision of QuakeCoRE.

Proposals will be evaluated against basic eligibility criteria:

- Budget: Budget is in line with funding guidelines and includes only eligible expenditure
- Eligibility: Project is led by an eligible member of the QuakeCoRE community
- Vision Mātauranga: Project demonstrates an appropriate consideration and incorporation of Vision Mātauranga
- Fit: Project is within programme scope

Projects that meet the basic eligibility criteria listed above will be sent to the review panel for assessment. The specific evaluation criteria used by the panel and their weighting are:

- Research Excellence (40%)
  - Quality of proposed research
  - Track record and ability to deliver proposed research
- Human Capacity Development (30%)
  - Involvement of students and emerging researchers
  - Development and support for members of under-represented groups (e.g.: women, Māori/Pasifika)
- Fit with QuakeCoRE Mission and Values (30%)
  - Priority of the proposed research for the QuakeCoRE Flagship objectives as stated in the relevant section of this Collaboration Plan and connection to the Flagship Programme
  - Commitment of investigators to the QuakeCoRE mission and values, including strong collaboration
  - Value of research relative to its cost
  - Relevance and translation to practice including direct and active involvement of end-users and stakeholders

### Vision Mātauranga

Proposals are requested that are developed to reflect Māori research needs, interests, objectives and priorities concerning Māori and national built, social, economic and environmental resilience to earthquakes.

Vision Mātauranga is a policy about innovation, opportunity and the creation of knowledge that highlights the potential contribution of Māori knowledge, resources and people. If you are not familiar with the Vision Mātauranga policy we suggest reading the MBIE [policy](#).

There are four themes:

- Indigenous Innovation, which involves contributing to economic growth through *distinctive research and development*;
- Taiao, which is concerned with achieving *environmental sustainability* through iwi and hapū relationships with land and sea;
- Hauora/Oranga, which centres around improving *health and social wellbeing*; and
- Mātauranga, which involves exploring *indigenous knowledge*.

Vision Mātauranga is now included as an assessment criterion for all QuakeCoRE projects.

Proposals should consider the relation of the research to the themes of Vision Mātauranga and, *where relevant*, how the project will engage with Māori.

Where research projects are of relevance to Māori or involve Māori, QuakeCoRE expects that applicants are in consultation with Māori at the planning stage, so as to achieve the best possible outcomes.

Where Flagship and Special Project Research Projects have demonstrated a strong relationship to Vision Mātauranga, additional support may be provided to assist with the engagement and implementation of the project's Vision Mātauranga activities. Any additional funding would be offered at the discretion of QuakeCoRE.

Researchers should consult their institutional advisor to get assistance in determining the relevance of the proposed project for Māori.

### **Key Criteria for 2019-20 RfP**

- Proposals will be assessed on the RfP selection criteria, however we have identified areas that where priority will be given where proposals appropriately support our focus on the following areas:
  - A: Research Masters Scholarships
    - Include students that identify as Māori or Pasifika, or female students in engineering disciplines..
    - Support Associate Investigators that identify as Māori or Pasifika; female Associate Investigators in engineering disciplines, and early-career Associate Investigators\*.
  - B: Flagship and Special Project Research Projects
    - Support projects aimed at securing future external funding.
    - Support Associate Investigators that identify as Māori or Pasifika; female Associate Investigators in engineering disciplines, and early-career Associate Investigators\*.

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\* Early-career Researchers are AIs and PIs that completed their PhD no more than 7 years ago, as at 19 October, 2018, extensions to this timeframe will be considered for parental leave or similar career breaks.

- C: Vision Mātauranga Focused Projects
  - Support the implementation of our Vision Mātauranga Strategy.
  - Support Investigators and students that identify as Māori.
  - Support projects aimed at securing future external funding.
  - Support Investigators that identify as Pasifika; female Investigators in engineering disciplines, and early-career Investigators\*.

The RfP Review Panel includes representation from Flagships, Technology Platforms, end-users and stakeholders.

All proposals will be reviewed by multiple RfP Review Panel members, avoiding any conflicts of interest. The RfP Review Panel members will be assigned proposals to independently review against the evaluation criteria above. A conflicts register will be kept to ensure that the review process has transparent conflict management. An independent observer will be present during the review meeting to provide an impartial view and ensuring that fair review processes are followed for all proposals.

The RfP Review Panel is responsible for recommending a balanced Collaboration Plan research budget to the QuakeCoRE Director, which will be combined into an annual spending plan for submission to the QuakeCoRE Board.

The review process is planned to be completed and applicants notified by mid-December 2018 for 21 month project funding which will commence on 1 January 2019.

## **7. Co-ordination with other research support**

Earthquake resilience research in Aotearoa New Zealand is supported by both QuakeCoRE and numerous other funding agencies, including the: Natural Hazards Research Platform (NHRP), NZ Earthquake Commission (EQC), Resilience to Natures Challenges National Science Challenge (RNC-NSC), MBIE Building Performance Branch, Callaghan Innovation, NZ Transportation Agency, Building Research Association NZ (BRANZ), Natural Infrastructure Unit (NIU), and UC Quake Centre (UCQC), among others. Earthquake resilience-related research in Aotearoa New Zealand has also been actively supported by numerous ‘general’ NZ funding agencies (e.g. Marsden Fund, Rutherford Discovery Fellowships, MBIE Contestable Round), international partnership funding (e.g. US NSF, JSPS, EU Framework Programme), and direct industry funding by numerous private companies.

It can be seen from the numerous and diverse range of funders above, that the annual funding provided by QuakeCoRE represents a small portion of the overall annual Aotearoa New Zealand spending on earthquake resilience R&D. QuakeCoRE thus focuses on providing enabling funding which will, among other things (see Section 6): (i) establish and foster collaborative research across institutions and disciplinary boundaries; (ii) establish new research directions, enhance existing research funded by other agencies through strategic directed funding, and deliver tangible end-user outcomes; and (iii) support underpinning Technology Platform Programmes which provide the experimental, data, and computational

infrastructure necessary to develop and accelerate collaborative research that addresses ‘system-level’ problems toward achieving earthquake resilience.

In the context of those comments above, investigators should ensure that submitted proposals ‘fit’ the QuakeCoRE vision, mission and evaluation criteria, and that their proposal identifies aligned funding from other funding agencies in Aotearoa New Zealand. Investigators should also ensure the proposal is not better suited to one of the other Earthquake Resilience R&D funders noted above.

## **8. Research Programmes**

The QuakeCoRE research programme structure is comprised of Technology Platforms and Flagships, as described in earlier sections. The sections below outline the priorities and requirements pertaining to the research programme, which investigators should utilize in developing proposals in response to this Annual Collaboration Plan. Project Leaders are encouraged to review the Coordinated Flagship Project summaries to identify how their proposal aligns with, and contributes to, this programme of work to support the QuakeCoRE mission. Further details can be found in the Flagship Coordinated Project [Summaries](#). Although the research programme deliverables will be met through the Flagship Coordinated Projects, Flagship Leaders have identified certain areas in which Flagship Research Projects are encouraged under this RfP. A list of these Flagship focus areas is included in this Annual Collaboration Plan [here](#).

### **8.1 Flagship programmes**

#### **Flagship 1: Ground motion simulation and validation**

This flagship will provide a paradigm shift in strong ground motion prediction in Aotearoa New Zealand and internationally through the use of high-fidelity physics-based prediction methods, which merge state-of-the-art knowledge in strong motion seismology and geotechnical earthquake engineering. The impact of this flagship will result from the reduction in the design level seismic hazard in many regions through an increased prediction precision, identification of regions with an increased seismic hazard resulting from systematic basin and topographic ground motion phenomena; quantification of ground motion intensity affecting spatially distributed infrastructure networks.

The key thrust areas are:

- FP1.1 Development and refinement of ground motion simulation methods that enable the generation of acceleration time series for the seismic response analysis of infrastructure.
- FP1.2 Development of ‘velocity models’ of the earth’s crust in new regions of Aotearoa New Zealand, or improvements in existing regions.
- FP1.3 Develop, validate, and apply models for nonlinear near surface site and topographic response for use in conjunction with ground motion simulation methods.

- FP1.4 Utilize ground motion simulations to forecast the severity of ground shaking over spatially-distributed regions in future major Aotearoa New Zealand earthquakes.
- FP1.5 Examination of modelling uncertainties in ground motion simulation methods and utilization for probabilistic seismic hazard analysis.
- FP1.6 Explore the role of simulated ground motions for use in seismic response analysis of engineering infrastructure, including comparisons with as recorded ground motions and development of procedures for simulated ground motions in infrastructure seismic design guidelines.

### **Flagship 2: Liquefaction impacts on land and infrastructure**

This flagship will develop new approaches and methodologies for quantification of impacts of soil liquefaction on land and infrastructure through a fundamental understanding of onset and consequences of liquefaction; and use these methods to assess liquefaction impacts throughout Aotearoa New Zealand and their potential to be mitigated. These novel methods will represent a major advance in the field, and will provide means for a robust assessment and treatment of liquefaction hazards at both site-specific and regional levels.

The key thrust areas are:

- FP2.1 Development and improvement of liquefaction assessment methods (Liquefaction Evaluation: Beyond Current State-of-Art and Practice). Utilize the exceptional databases compiled during Canterbury and Kaikōura Earthquakes, and obtain additional high-quality data where needed, to develop new or improve existing liquefaction evaluation procedures (field, laboratory and analytical tools and methodologies) that will adequately address current and future society needs for performance of land and infrastructure during earthquakes.
- FP2.2 Identify critical issues and ground conditions related to liquefaction impacts on infrastructure, including characterization of important but challenging Aotearoa New Zealand soils, and the development of adequate assessment procedures and cost-effective mitigation strategies.
- FP2.3 Development of performance based criteria for micro systems (eg soil deposits; soil-foundation-building systems) and macro systems (urban areas; land use and development) and lifeline networks, integrating geotechnical engineering knowhow within cross-disciplinary tools and methodologies.

### **Flagship 3: Addressing earthquake-vulnerable buildings – A multidisciplinary approach**

This flagship will result in the development and validation of procedures to forecast the socio-economic impacts of building demolitions and retrofits that are legislated to occur within the coming decade. Improved assessment guidance will mitigate conservative seismic assessments that result in unnecessary demolition of existing buildings, including the country's built heritage, enabling economically-viable policy solutions. Proven cost-effective and

architecturally-appropriate earthquake strengthening solutions will be developed and communicated to structural engineers nationwide so that results can be immediately implemented. Consideration will be given to the range of existing buildings posing a risk in Aotearoa New Zealand's cities, not just those classified as earthquake-prone by legislation.

The key thrust areas are:

- FP3.1 Development of validated methodologies for detailed assessment and improvement of earthquake-vulnerable buildings such as unreinforced masonry and reinforced concrete buildings. Where possible, validation may be achieved via field testing in buildings scheduled for demolition.
- FP3.2 Development of methodologies for economic assessment of options for addressing earthquake-vulnerable buildings, namely: mitigation, demolition, or no action.
- FP3.3 Understanding the development of policy and initiatives regarding earthquake-vulnerable buildings, including understanding societal involvement and expectations in such policy.

#### **Flagship 4: Next-generation infrastructure - Low-damage and repairable solutions**

This flagship will seek a new design paradigm whereby reparability and damage-control is explicitly considered in the design process. This requires the development of new low-damage systems, quantification of the reparability (cost and time) of conventional systems, and design process methodologies for implementation. This flagship will also result in important changes to implementation standards; which provide the mainstream technology transfer mechanism given that all future designs must satisfy these standards. Significant economic benefits are also expected through both reductions in future earthquake losses and increased international competitiveness of Aotearoa New Zealand engineering consultants and marketing of new seismic protective devices.

The key thrust areas are:

- FP4.1 Development of new technologies for buildings (structural and non-structural) to control damage in future events and enable rapid recovery.
- FP4.2 Development of procedures to reliably assess and communicate the performance of new and conventional systems, including consideration of residual capacity of earthquake-damaged infrastructure and cost-effective repair techniques.
- FP4.3 Integration of reparability performance objectives into implementation standards and alignment with insurance policies optimised for rapid recovery.

#### **Flagship 5: Pathways to improved resilience**

Our goal in Flagship 5 is to identify how societal decisions and choices affect the social, culture and economic resilience of communities, at local, regional and national scales. QuakeCoRE will bring together expertise from a range of disciplines, including tangata whenua knowledge to develop a holistic understanding of social, cultural and economic impacts from earthquakes;

thus, providing key input to policy decisions at all levels of government and building a resilience community of practice.

The key thrust areas are:

- FP5.1 Addressing key knowledge gaps to improve our ability to holistically evaluate impacts of earthquakes, to understand and model system effects, and to advance our capability to evaluate the case for investment.
- FP5.2 Analysis and sharing of current tools and methodologies used for the evaluation of resilience-building policies and practices in order to identify opportunities for innovative cross-sectorial and organisational research collaboration.
- FP5.3 Development and evaluation of up to 6 Wellington case study activities which critically assess potential investment policies and practices to improve Aotearoa New Zealand's resilience to earthquakes; and their use to provide inventive recommendations and advice for practical implementation.

## **8.2 Special project**

### **Special Project 1: Spatially-distributed infrastructure**

This Special Project seeks to develop tools to assess the seismic performance of spatially-distributed infrastructure networks subject to extreme natural hazards.

The key thrust areas are:

- SP1.1 Components: Performance of individual network components and assessment of their vulnerabilities.
  - Assess the applicability of distributed infrastructure fragility functions developed for the Christchurch earthquakes for other areas in Aotearoa New Zealand
  - Development of guidelines from the lessons and repair/retrofit techniques from Christchurch.
  - Development of Aotearoa New Zealand specific infrastructure fragility functions based on experimental and computational modelling.
  - Define tipping points and service outage levels for critical infrastructure components and how this translates to system level performance.
- SP1.2 Networks: Development and application of methodologies to quantify the performance of spatially-distributed networks.
  - Quantification of the interaction between individual components of networks.
  - Assess the effect of multi-hazards and cascading impacts on network performance.
  - Quantify interdependencies between different networks.
  - Development of methodologies to link individual component performance and level of service with distributed infrastructure network models.
- SP1.3 Implementation: Incorporation of resilience concepts into network decision making.
  - Quantify the effect of pre-event mitigation and post-event prioritization decisions on resilience of networks.
  - Development of methodologies to link distributed infrastructure network performance measures with economic and social impact metrics/models.

### **8.3 RfP Flagship Focus Areas for 2019-20**

For 2019-20, Flagship Leaders have confirmed that our Coordinated Flagship Projects will address all of the key tasks identified in the flagship research programmes in our TEC three-year plan. No thrust areas or deliverables have been identified as critical gaps.

In the RfP we are seeking research proposals that contribute to the delivery of our research programme. Our Flagship Leaders have identified the following focus areas where Flagship Research Projects are encouraged in this RfP:

#### Flagship 1 – Ground Motion Simulation and Validation

- Sedimentary basin characterisation - to enable the development of simplified and detailed basin models for ground motion simulation with increased resolution.
- Examination, sensitivity and treatment of ground motion simulation uncertainties.
- Application of ground motion simulations for use in earthquake engineering practice.

#### Flagship 2 – Liquefaction Impacts on Land and Infrastructure

- Liquefaction Assessment and Mitigation of systems and networks
  - (i) soil-foundation-structure systems;
  - (ii) spatially distributed systems and networks (lifelines)

#### Flagship 3 – Addressing Earthquake-vulnerable Buildings – A Multidisciplinary Approach

- Addressing earthquake-vulnerable buildings in regional towns, including unreinforced masonry buildings.

#### Flagship 4 – Next-generation Infrastructure – Low-damage and Repairable Solutions

- Identifying, within a social and/or legal context, suitable performance-objectives for the seismic design of new buildings.

#### Flagship 5 – Pathways to Improved Resilience

- How societal decisions and choices affect the social, culture and economic resilience of communities, at local and regional scales.

Projects should be complimentary to the Coordinated Flagship Projects and contribute to the QuakeCoRE research programme deliverables from our TEC three-year plan; a summary of the Coordinated Flagship Projects for 2019-2020 and our TEC deliverables is available [here](#).